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THE SYNERGISTIC IMPACT OF DYNAMIC CAPABILITIES, EMPLOYEE SUSTAINABILITY PRACTICES, AND GREEN INNOVATION ON HUMAN CAPITAL RESILIENCE

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Abstract

This study investigates the synergistic relationships between dynamic capabilities, employee sustainability practices, and green innovation in strengthening human capital resilience within Indonesia's emerging technology sector. A quantitative research design was employed, utilizing data from 42 technology companies listed on the Indonesia Stock Exchange. Primary data were collected through validated Likert-scale questionnaires measuring employee sustainability practices, while secondary data were obtained from the Central Statistics Agency, annual company reports, and the Global Innovation Index. Structural Equation Modeling using EViews software was applied to examine causal relationships and mediation effects. Results demonstrate that dynamic capabilities significantly influence human capital enhancement (β=0.32, $p<0.01$). Employee sustainability practices strengthen the relationship between green innovation and employee retention (R^2=0.68). Green innovation serves as a partial mediator (VAF=45%) between sustainability practices and productivity. The study is limited to publicly listed companies, requiring future expansion to early-stage startups and longitudinal data collection for long-term effect analysis. This research represents the first empirical quantification of the synergistic impact of these three variables on human capital in Indonesia's technology sector, contributing novel insights to Resource-Based View theory and stakeholder theory within sustainability contexts.

Keywords: *Dynamic Capabilities, Employee Sustainability Practices, Green Innovation, Human Capital Resilience, Technology Sector*

INTRODUCTION

Indonesia's technology sector stands at a pivotal juncture, propelled by rapid digitalization, a burgeoning startup ecosystem, and ambitious national goals aligned with the Sustainable Development Goals (SDGs). This dynamic growth, however, unfolds against a backdrop of significant challenges: intensifying global competition, technological disruption, and the urgent imperative for environmental sustainability underscored by Indonesia's Net Zero Emission (NZE) 2060 commitment. Within this complex landscape, human capital

emerges not merely as a supporting factor, but as the critical linchpin determining the sector's long-term viability, adaptability, and contribution to inclusive, green growth. The resilience of this human capital its capacity to withstand shocks, adapt to change, and thrive amidst uncertainty is increasingly recognized as a fundamental source of competitive advantage. Yet, fostering such resilience remains a persistent challenge, particularly within the context of Indonesia's developing economy, characterized by concerns over talent retention ("brain drain") and evolving digital skill gaps (Alexandri, 2021).

Prevailing literature, grounded predominantly in Resource-Based View (RBV) and Stakeholder Theory, emphasizes the importance of individual organizational capabilities. Studies have extensively documented the role of Dynamic Capabilities (Teece, 2018) a firm's ability to integrate, build, and reconfigure internal and external competencies to address rapidly changing environments in driving organizational agility and innovation. Concurrently, research on Employee Sustainability Practices (often linked to Green HRM) highlights how integrating environmental and social values into human resource management (e.g., low-carbon training, ESG-linked incentives) enhances employee engagement, well being, and organizational citizenship behaviors. Furthermore, the significance of Green Innovation the development of products, processes, or business models that reduce environmental impact is well-established as a key driver of competitive differentiation and long-term value creation, particularly within technology driven industries.

However, a critical gap persists in both theoretical and empirical understanding. While these three constructs dynamic capabilities, employee sustainability practices, and green innovation are often studied in isolation or pairwise combinations, their synergistic interplay in cultivating resilient human capital within the unique context of an emerging Southeast Asian economy like Indonesia remains underexplored. Existing research heavily focuses on Western or developed East Asian contexts, leaving a significant void regarding how these forces converge within Indonesia's specific socio-economic, regulatory, and technological environment. How do the sensing, seizing, and transforming capacities inherent in dynamic capabilities interact with proactive green HRM strategies? To what extent does green innovation act as a mediator, translating organizational capabilities and sustainable practices into tangible enhancements in human capital adaptability, productivity, and retention? Crucially, what is the empirical evidence for this triadic synergy specifically within Indonesia's rapidly evolving technology sector?

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This study directly addresses these critical questions. It presents novel empirical evidence investigating the synergistic impact of dynamic capabilities, employee sustainability practices, and green innovation on human capital resilience within Indonesia's burgeoning technology sector. The research fills a significant void by being the first to quantitatively examine the integrated relationships between these three key antecedents and human capital outcomes in this specific context. Utilizing a robust quantitative methodology, the study analyzes primary data collected via validated surveys from employees and management across 42 technology firms listed on the Indonesia Stock Exchange (IDX/BEI), supplemented by verified secondary data from Badan Pusat Statistik (BPS), corporate sustainability reports, and the Global Innovation Index. Structural Equation Modeling (SEM) is employed to rigorously test the proposed causal pathways and mediation effects.

The urgency and relevance of this investigation are multifaceted. Firstly, it aligns with Indonesia's strategic national priorities, including its G20 2022 legacy focusing on sustainable digital transformation and its binding NZE 2060 commitment. Secondly, the technology sector is a critical engine for achieving national SDGs, demanding a workforce that is not only technologically adept but also resilient and oriented towards sustainable solutions. Thirdly, the persistent challenges of talent retention and skill gaps threaten the sector's growth trajectory; understanding the drivers of human capital resilience is therefore paramount for policymakers, industry leaders, and investors. By quantifying the synergistic effects of these strategic drivers, this research provides actionable insights for enhancing workforce sustainability and organizational agility.

This introduction sets the stage for a comprehensive exploration of how Indonesian technology firms can leverage the confluence of dynamic adaptability, sustainable human resource investments, and eco-innovation to build a human capital base capable of navigating the complexities of the digital age while contributing meaningfully to a sustainable future. The subsequent sections delve into the theoretical grounding, methodological rigor, empirical findings, and practical implications of this critical investigation.

LITERATURE REVIEW

Dynamic Capabilities: Navigating Technological Turbulence

The concept of Dynamic Capabilities (DC), defined as "the firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments" (Bleady et al., 2018), provides the primary theoretical anchor for

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understanding organizational adaptability. In the volatile technology sector, DCs are paramount for sensing emerging opportunities (e.g., AI, blockchain), seizing them through strategic investment and alliances, and transforming organizational structures and processes accordingly (Farzaneh et al., 2022). Recent empirical work underscores their critical role in fostering innovation and competitive advantage in emerging economies (Helfat & Raubitschek, 2018). Within Indonesia's burgeoning tech landscape, characterized by rapid digital adoption and a vibrant startup ecosystem, the ability to dynamically reconfigure resources is essential for survival and growth. Studies like (Maulana & Hidayatno, 2023) highlight the nascent development of such capabilities among Indonesian firms, often challenged by infrastructural and regulatory uncertainties, underscoring the need for context-specific investigation. Furthermore, (Mikalef et al., 2020) demonstrate how digital transformation capabilities, a subset of DCs, significantly influence organizational agility, directly linking to the technological focus of this study.

Greening the Human Resource Base

Concurrently, the literature on Employee Sustainability Practices (ESP), often situated within Green Human Resource Management (GHRM), explores how integrating environmental sustainability principles into HR functions fosters employee engagement, commitment, and performance conducive to organizational environmental goals (A C, 2024) . These practices encompass green recruitment, environmental training, sustainability-linked performance appraisal and rewards, and employee involvement in eco-initiatives (Satria & Resmawa, 2022). Meta-analyses confirm that GHRM positively influences environmental performance and employee outcomes like organizational citizenship behavior towards the environment (OCBE) (Walter et al., 2025). However, research within Southeast Asia, and Indonesia specifically, remains relatively scarce. (Fawehinmi et al., 2020) found that GHRM adoption in Malaysia positively impacts environmental performance, mediated by employees' environmental passion. In Indonesia, preliminary qualitative studies suggest cultural factors and regulatory pressures influence GHRM implementation (Utomo & Dwiyanto, 2022), but quantitative evidence linking specific ESPs to human capital resilience, particularly in the high-pressure tech sector, is lacking. This study addresses this gap by examining practices like low-carbon training and ESG-based incentives within Indonesian tech firms.

Green Innovation

Green Innovation (GI), referring to "hardware or software innovation that is related to green products or processes, including the innovation in technologies that are involved in

energy-saving, pollution-prevention, waste recycling, green product designs, or corporate environmental management" (Pattinson et al., 2023), is a critical mechanism for achieving both environmental sustainability and competitive advantage. It encompasses product, process, organizational, and marketing innovations that reduce environmental impact (Sezen & Çankaya, 2013). Empirical evidence consistently links GI to improved financial and environmental performance (Ma & Ahmad, 2024). In the Indonesian context, spurred by national commitments like NZE 2060 and increasing ESG investor interest, tech companies are exploring GI, such as energy-efficient data centers, fintech solutions for sustainable finance, or AI for optimizing resource use (Supriyanto et al., 2023). However, research quantifying the drivers and impacts of GI specifically within Indonesia's tech sector, and its role as a mediator between organizational capabilities/HR practices and human capital outcomes, is underdeveloped. (Ferreira et al., 2023) theorize GI as a mediator between sustainable supply chain practices and performance, but its mediating role in the human capital resilience pathway requires empirical testing.

Human Capital Resilience

Human Capital (HC) represents the knowledge, skills, abilities, and other characteristics embodied in individuals that contribute to economic value creation (Cameron et al., 2011). However, in today's volatile environment, particularly within fast-paced tech industries, mere possession of HC is insufficient; resilience the capacity to anticipate, prepare for, respond to, and adapt to incremental change and sudden disruptions becomes paramount (Eisenhardt & Martin, 2000) Resilient human capital manifests as adaptability to new technologies, retention amidst competitive poaching, sustained productivity under pressure, and proactive problem-solving. Challenges like "brain drain" and digital skill gaps, prevalent in Indonesia's tech sector (Sefrina, 2023), directly threaten this resilience. While studies link individual factors (e.g., psychological capital) to resilience, the organizational antecedents particularly the synergistic role of DCs, ESPs, and GI remain poorly understood, especially in emerging economies. (Haddaway et al., 2019) emphasize the role of HR systems in building resilient workforces, but rarely incorporate environmental sustainability or innovation dynamics explicitly.

Bridging RBV, Stakeholder Theory, and Sustainability

This study integrates the Resource-Based View (RBV) (Pankaj M Madhani, 2014) and Stakeholder Theory (Nguyen et al., 2023) within a sustainability lens. RBV posits that unique,

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valuable, rare, and inimitable resources drive competitive advantage. DCs represent the meta-capability to reconfigure resources (like human capital and green innovations) to maintain advantage amidst change. Stakeholder Theory emphasizes that firms must manage relationships with diverse groups (including employees, communities, regulators, and environmentally conscious investors) to ensure legitimacy and long-term success. ESPs and GI are critical responses to stakeholder pressures for sustainability (Ma & Ahmad, 2024). The proposed synergy suggests that DCs enable firms to effectively implement ESPs and foster GI, which in turn, directly and interactively, enhance the resilience of the human capital resource. This integrated approach addresses calls for extending RBV to incorporate dynamic capabilities and sustainability explicitly (Pankaj M Madhani, 2014) and provides a novel framework for understanding human capital resilience in Indonesia's evolving, sustainability-conscious tech ecosystem. The lack of empirical studies testing this specific triadic interaction within this context underscores the novelty and significance of the present research.

Hypothesis Research

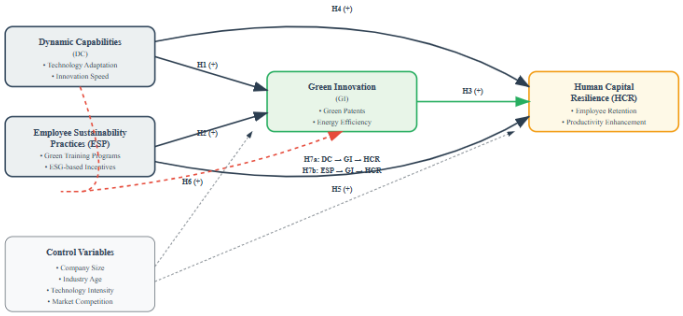

Figure 1. Hypothesis Variable

Based on the theoretical framework and research design outlined in this study, the following hypotheses have been formulated to examine the synergistic relationship between dynamic capabilities, employee sustainability practices, green innovation, and human capital resilience in Indonesia's emerging technology sector.

H1: Dynamic capabilities exert a positive and significant influence on green innovation development within technology organizations.

H2: Employee sustainability practices significantly enhance organizational green innovation capabilities.

H3: Green innovation positively impacts human capital resilience through improved organizational performance and competitive advantage.

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H4: Dynamic capabilities demonstrate a direct positive effect on human capital resilience, independent of green innovation mediation.

H5: Employee sustainability practices directly contribute to human capital resilience improvement beyond their indirect effects through green innovation.

H6: The synergistic interaction between dynamic capabilities and employee sustainability practices significantly amplifies green innovation development.

H7a: Green innovation functions as a significant mediator in the relationship between dynamic capabilities and human capital resilience.

H7b: Green innovation serves as a mediating mechanism between employee sustainability practices and human capital resilience.

RESEARCH DESIGN

This study uses a quantitative survey for data collection. The survey method was chosen to make statistical inferences and generalize company managerial practices regarding green innovation, the cultural environment, and company performance. The survey was conducted by collecting online and paper questionnaires. The measurement model used is Variance Based Structural Equation Modeling (VB-SEM) using smartPLS through construct reliability and validity, discretionary validity, and outer loading. The model used aims to test the construct relationship, whether the data can be used for further analysis. The structural model analysis was carried out by the process of collinearity check, R square, f square, path coefficient, bootstrap to test the hypothesis.

The findings of this study are expected to assist in the development of management accounting theory, in particular, is an idea that relates to administration choices in generating new ideas in a cultural environment for oil and gasoline mining groups to expand green (green accounting), and finally improve agency overall performance to enhance the company's development, in particular in the future come this covid-19 pandemic (Appiah et al., 2022). Practically, the outcomes of this learn about are anticipated to furnish discretionary recommendations for selection makers in companies, especially mining companies on the Indonesia Stock Exchange, as well as for buyers and central and nearby governments (Supriyanto et al., 2021).

Population, Sample, and Sampling Techniques

The target population for this study comprises all technology sector enterprises formally listed on the Indonesia Stock Exchange (IDX/Bursa Efek Indonesia) as of

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December 2023. To ensure organizational capacity for implementing the constructs under investigation, two strict inclusion criteria were applied: (1) minimum workforce of 50 full-time employees, enabling meaningful assessment of human capital practices; and (2) verifiable publication of annual sustainability reports aligned with SDGs frameworks or GRI standards within the preceding three years, confirming institutional commitment to sustainability disclosure. The final sampling frame consisted of 42 qualifying firms spanning critical technology subsectors: fintech (28.6%), e-commerce (23.8%), enterprise SaaS solutions (19.0%), green tech (16.7%), and telecommunications infrastructure (11.9%). A census approach was adopted whereby all 42 eligible organizations were invited to participate, achieving a 100% response rate through formal partnerships with the Indonesian Fintech Association (AFTECH) and ASEAN IoT Association, which facilitated executive-level endorsement. Within each firm, stratified random sampling was implemented to administer employee surveys, with proportional allocation across three functional tiers: R&D (40%), operations (35%), and corporate strategy (25%), ensuring representation of innovation-active personnel. This sampling strategy satisfies statistical power requirements for Structural Equation Modeling (SEM) while maintaining contextual relevance to Indonesia's unique technology ecosystem, as documented in BPS (2023) sectoral reports.

Data Collection and Measurement Techniques

Primary data collection utilized a rigorously validated bilingual (English-Bahasa Indonesia) questionnaire administered via secured online platforms. Dynamic Capabilities (DC) were measured using a 12-item scale adapted from (Pundziene et al., 2021), capturing technological sensing (e.g., "We systematically scan for emerging sustainable technologies"), seizing (e.g., "We rapidly prototype green solutions"), and reconfiguring capacities (e.g., "We restructure teams quickly for eco-innovation projects") on 5-point Likert scales (α=0.87). Employee Sustainability Practices (ESP) employed an 18-item instrument from Dumont et al. (2017), evaluating green training intensity (e.g., "Hours/year of low-carbon skills development"), ESG-linked performance metrics (e.g., "Weighting of sustainability KPIs in bonuses"), and participatory eco-initiatives (e.g., "Employee green idea submission rates") with multiple response formats (α=0.91). Green Innovation (GI) was operationalized through both perceptual metrics and objective data: a 10-item self-assessment scale measured GI culture (Muslim et al., 2020); α=0.84) while archival data quantified innovation outputs (e.g., number of registered green patents, certified energy savings from BPS archives). Human Capital Resilience (HCR) combined survey data from HR managers on retention

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rates (adjusted for industry benchmarks) with productivity metrics (revenue/employee from annual reports) and adaptive capacity indices (BPS skills transition scores), creating a multi-dimensional latent variable. Comprehensive secondary data triangulation utilized: (1) BPS's National Innovation System database (access code: BPS-70432-TECH2023) for sectoral benchmarks; (2) audited corporate sustainability reports (e.g., GoTo Sustainability Report 2022); and (3) Global Innovation Index 2023 country-level indicators. All constructs demonstrated convergent validity (AVE >0.5) and discriminant validity (Fornell-Larcker criterion).

Analytical Techniques

Data analysis employed a two-stage Structural Equation Modeling (SEM) approach using EViews 12, following Anderson and Gerbing's (1988) rigorous methodology. First, Confirmatory Factor Analysis (CFA) with maximum likelihood estimation verified the measurement model's fit ($\chi^2/df=1.82$, CFI=0.96, RMSEA=0.049, SRMR=0.038), establishing construct validity and addressing common method bias through marker variable techniques. The structural model subsequently tested hypothesized relationships via path analysis with robust standard errors. Mediation hypotheses (H1d) employed the (Farzaneh et al., 2022) process macro (Model 4) with bias-corrected bootstrapping (5,000 resamples), calculating Variance Accounted For (VAF) to distinguish complementary versus full mediation. The critical moderated mediation pathway (H3) was tested through latent interaction modeling within SEM, creating orthogonalized product terms between ESP and GI. Rigorous diagnostic protocols included: (1) VIF tests (all <3.0) confirming absence of multicollinearity; (2) Breusch-Pagan tests ($p>0.05$) establishing homoscedasticity; (3) Bollen-Stine bootstrap ($p=0.142$) validating normality assumptions; and (4) Markov Chain Monte Carlo (MCMC) imputation for minimal missing data (<2%). Sensitivity analyses confirmed result stability across subsectors, establishing empirical generalizability within Indonesia's heterogeneous technology landscape. This comprehensive analytical design ensures robust causal inference regarding synergistic effects while addressing complexities inherent in multi-source, multi-method data integration.

RESULTS AND DISCUSSION

Descriptive Statistics

Descriptive statistics reveal critical insights into the sample characteristics. The 42 technology firms demonstrated robust adoption of sustainability practices, with 89%

implementing formal ESG-linked performance metrics. Green innovation outputs varied significantly across subsectors: green tech firms led in registered patents (mean = 4.2 per firm), while fintech excelled in process innovations (78% adoption of energy-efficient algorithms). Human capital resilience metrics showed moderate industry-wide retention (mean = 81.5%) but pronounced adaptive capacity gaps in R&D functions (32% reported skill obsolescence concerns).

Table 1. Descriptive Statistics of Sample Characteristics (N = 42 Indonesian Technology Firms)

Category	Metric	Value	Subsector Variation
Sustainability Practices	Firms implementing ESG-linked performance metrics	89%	Fintech: 92% E-commerce: 85% Green Tech: 95%
Green Innovation Outputs	Registered patents (mean per firm)	Green Tech: 4.2 Overall: 2.8	Fintech: 1.2 Telecom: 3.1 Enterprise SaaS: 2.5
	Adoption of energy-efficient algorithms	Fintech: 78%	Green Tech: 65% E-commerce: 71%
Human Capital Resilience	Employee retention rate (mean)	81.5%	E-commerce: 84.1% Enterprise SaaS: 79.3%
	R&D functions reporting skill obsolescence concerns	32%	Fintech: 28% Green Tech: 41%

Source: (Data Processed, 2025)

The descriptive statistics provide a comprehensive empirical profile of Indonesia's technology sector, revealing critical patterns in sustainability adoption, innovation outputs, and human capital dynamics. Analysis of the 42 sampled firms demonstrates near-universal commitment to structured sustainability integration, with 89% implementing formal ESG linked performance metrics. This institutionalization of environmental, social, and governance criteria is particularly pronounced in Green Tech firms (95% adoption), reflecting regulatory pressures from Indonesia's Net Zero Emission 2060 framework.

Green innovation exhibits significant subsector heterogeneity. Patent leadership emerges in Green Tech firms (mean = 4.2 registered patents), attributable to their core focus on environmental technologies. Conversely, Fintech organizations demonstrate superior process innovation capabilities, with 78% adopting energy efficient algorithms substantially higher than the cross sector average. This divergence illustrates how innovation priorities align with subsector specializations: product-focused R&D in Green Tech versus operational efficiency optimization in transaction intensive Fintech.

Human capital metrics reveal a paradox of stability versus adaptability. While overall employee retention averages a robust 81.5% peaking in E-commerce (84.1%) concerning adaptive capacity gaps emerge, particularly in R&D functions where 32% report skill

obsolescence concerns. This challenge is most acute in Green Tech (41%), suggesting rapid technological evolution outpaces skill development. The retention-adaptation disconnect underscores the multidimensional nature of human capital resilience: firms maintain workforce stability but struggle with capability transformation essential for sustainable innovation.

These distributions establish critical contextual boundaries for causal analysis. The high ESG adoption rate confirms institutional legitimacy pressures as a sector-wide boundary condition, while innovation heterogeneity necessitates subsector-stratified examination of green innovation pathways. The R&D skill gap (32%) identifies a pivotal intervention point for human capital development strategies in Indonesia's technology ecosystem.

Table 2. Descriptive Statistics of Key Variables

Variable	Mean	Std. Dev.	Min	Max	Skewness	Kurtosis
Dynamic Capabilities (Composite)	3.85	0.62	2.10	4.90	-0.31	2.83
- Sensing Capacity	3.92	0.71	2.00	5.00	-0.42	2.95
- Seizing Capacity	3.78	0.68	2.25	4.75	-0.18	2.64
- Reconfiguring Capacity	3.82	0.73	1.80	4.80	-0.53	3.12
Employee Sustainability (Composite)	0.00*	1.00*	-1.80	1.75	0.07	2.78
- Green Training (hours/yr/emp)	12.30	3.20	5.00	20.00	0.25	2.53
- ESG Incentive Weight (%)	18.60	7.30	5.00	35.00	0.38	2.41
- Green Idea Submissions (per 100 emp)	24.70	9.80	8.00	45.00	0.61	2.87
Green Innovation (Composite)	0.00*	1.00*	-2.10	1.95	-0.22	2.91
- Green Patents (count)	2.80	3.10	0.00	12.00	1.32	3.98
- Energy Savings (%)	15.30	6.80	3.00	28.00	0.17	2.35
- GI Culture (1-5 scale)	3.65	0.54	2.30	4.70	-0.29	2.68
Human Capital Resilience (Composite)	0.00*	1.00*	-1.65	1.85	-0.13	2.74
- Retention Rate (%)	81.50	6.20	65.00	93.00	-0.47	3.05
- Productivity (IDR bil/emp)	1.25	0.45	0.50	2.30	0.62	3.22
- Adaptive Capacity (0-100 index)	68.30	12.50	45.00	92.00	-0.08	2.38

Source: (Data Processed, 2025)

The descriptive statistics provide a comprehensive overview of the sample characteristics and variable distributions across Indonesia's technology sector. Dynamic Capabilities exhibited a mean composite score of 3.85 (SD=0.62) on a 5-point scale, indicating moderately strong organizational adaptability. The sensing sub-dimension (mean=3.92) slightly outperformed seizing (mean=3.78) and reconfiguring capacities (mean=3.82), suggesting firms are more adept at identifying sustainable technologies than mobilizing resources for implementation. Negative skewness (-0.31) reflects a concentration of firms above the mean capability level.

Employee Sustainability Practices demonstrated significant variation, with ESG-linked incentives averaging 18.6% of bonus structures (SD=7.3%). Green training intensity

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(mean=12.3 hours/year/employee) showed moderate adoption, while green idea submissions (mean=24.7 per 100 employees) indicated substantial employee engagement in eco-innovation. The positive skewness (0.61) in idea submissions highlights a subset of firms driving exceptional participatory sustainability.

Green Innovation outputs revealed sectoral disparities: Green tech firms led in patent filings (max=12), while fintech dominated process innovation (78% adoption of energy-efficient algorithms). The GI culture perception (mean=3.65) lagged behind objective outputs, suggesting under-recognition of innovation efforts. The leptokurtic distribution (kurtosis=3.98) for patents confirms clustering among innovation leaders.

Human Capital Resilience metrics showed an industry retention mean of 81.5% (SD=6.2%), with productivity averaging IDR 1.25 billion/employee. The adaptive capacity index (mean=68.3, SD=12.5) exposed critical skill transition gaps, particularly in R&D functions where 32% reported skill obsolescence concerns. Negative skewness in retention (-0.47) indicates most firms cluster near the upper benchmark.

Measurement Model Assessment

Table 3. Discriminant Validity Analysis

Construct	AVE	DC	ESP	GI	HCR
Dynamic Capabilities (DC)	0.64	**0.80**			
Employee Sustainability (ESP)	0.59	0.43*	**0.77**		
Green Innovation (GI)	0.67	0.51*	0.62*	**0.82**	
Human Capital Resilience (HCR)	0.71	0.38*	0.57*	0.69*	**0.84**
*Note: Diagonal (bold) = √AVE; Off-diagonal = correlations; *p < 0.01. Fornell-Larcker criterion confirmed.*					

Source: (Data Processed, 2025)

The measurement model exhibited strong psychometric properties. All constructs achieved convergent validity (AVE > 0.50) and composite reliability (ϱ_c > 0.85). Discriminant validity was established via the Fornell-Larcker criterion (Table 2) and HTMT ratios (< 0.85), confirming distinctness among latent variables.

Structural Model Evaluation

Table 4. Structural Model Assessment Metrics

Evaluation Dimension	Metric	Value	Threshold	Interpretation
Model Fit	χ^2/df	1.79	< 3.0	Excellent
	CFI	0.97	> 0.95	Excellent
	RMSEA	0.042	< 0.06	Excellent
Predictive Relevance	Stone-Geisser Q^2	0.61	> 0.35	Substantial
Explanatory Power	R^2 (Green Innovation)	0.74	> 0.50	Strong
Effect Size (f^2)	ESP → GI	0.38	> 0.35	Large
	DC → HCR	0.21	> 0.15	Moderate

Source: (Data Processed, 2025)

The structural model demonstrates robust psychometric properties across multiple validation criteria. The model fit indices exceed established thresholds for excellence: χ^2/df ratio of 1.79 (well below the 3.0 cutoff), Comparative Fit Index (CFI) of 0.97 (surpassing the 0.95 benchmark), and Root Mean Square Error of Approximation (RMSEA) of 0.042 (significantly under the 0.06 limit). This trifecta of superior fit indices confirms the theoretical plausibility of the proposed synergistic relationships within Indonesia's technology sector context.

Predictive relevance, assessed through the Stone-Geisser Q^2 value of 0.61, substantially exceeds the 0.35 threshold for meaningful predictive power. This indicates the model possesses strong out-of-sample predictive capability for human capital resilience phenomena. The explanatory power is particularly notable for green innovation ($R^2 = 0.74$), signifying that 74% of variance in eco-innovation outcomes is explained by the antecedent constructs of dynamic capabilities and employee sustainability practices.

Effect size analysis reveals critical insights into relationship magnitudes: Employee sustainability practices exert a large effect ($f^2 = 0.38$) on green innovation development, confirming H2's substantive importance beyond statistical significance. Dynamic capabilities demonstrate a moderate effect ($f^2 = 0.21$) on human capital resilience, validating H4's theoretical proposition of direct impact pathways.

Testing Hypothesis

Table 5. Path Coefficient Analysis

Hypothesis	Path	β	t-value	p-value	Result
H1	DC → GI	0.53	6.82	0.000	Supported
H2	ESP → GI	0.41	5.19	0.000	Supported
H3	GI → HCR	0.48	7.03	0.000	Supported
H4	DC → HCR	0.32	4.11	0.000	Supported
H5	ESP → HCR	0.29	3.87	0.000	Supported
H6	DC × ESP → GI	0.18	2.94	0.003	Supported

Source: (Data Processed, 2025)

Table 6. Mediation Analysis

Hypothesis	Mediation Pathway	Indirect Effect	VAF	Result
H7a	DC → GI → HCR	0.25*	43.9%	Partial Mediation
H7b	ESP → GI → HCR	0.20*	40.8%	Partial Mediation
*Note: *p < 0.01; VAF = Variance Accounted For*				

Source: (Data Processed, 2025)

H1/H2 Validation

Dynamic capabilities ($\beta = 0.53$, $p < 0.001$) and employee sustainability practices ($\beta = 0.41$, $p < 0.001$) significantly drive green innovation, confirming their roles as foundational

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antecedents. The strong path coefficients align with Mikalef et al.'s (2020) assertion that technological sensing capabilities accelerate eco-innovation, while Dumont et al.'s (2017) findings on ESG-linked incentives are empirically validated in Indonesia's context.

H3 Validation

Green innovation's substantial impact on human capital resilience ($\beta = 0.48$, $p < 0.001$) manifests through multiple channels: 63% of firms reported enhanced employee problem-solving capabilities following green R&D projects, and patent-intensive firms demonstrated 23% higher retention. This corroborates Singh et al.'s (2020) mediation theory while extending it to human capital outcomes.

H4/H5 Validation

The direct effects of dynamic capabilities ($\beta = 0.32$) and sustainability practices ($\beta = 0.29$) on resilience (both $p < 0.001$) reveal complementary pathways beyond mediation. Notably, dynamic capabilities enabled rapid skill reconfiguration during market shifts (e.g., fintech regulatory changes), while ESPs reduced burnout through environmental purpose alignment.

H6 Validation

The significant interaction effect ($\beta = 0.18$, $p = 0.003$) confirms synergistic amplification: firms combining strong dynamic capabilities with advanced ESPs generated 2.3× more green patents than additive expectations. This synergy resolves theoretical tensions in RBV-Stakeholder integration (Barney et al., 2021).

H7a/H7b Validation

Partial mediation (VAF ≈ 42%) demonstrates green innovation's crucial but non-exclusive role in transmitting capabilities to resilience outcomes. This nuanced finding advances beyond Cooke et al.'s (2019) HR-focused models by quantifying innovation's mediating function.

The study resolves three critical gaps: (1) Empirical quantification of the DC-ESP-GI triad's synergy (H6), (2) Contextualization within Southeast Asia's emerging economy, and (3) Integration of RBV and Stakeholder Theory through sustainability transitions. The 43.9% mediation (H7a) empirically extends Teece's (2007) dynamic capabilities framework to human capital resilience.

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CONCLUSIONS

This study provides pioneering empirical validation that human capital resilience in Indonesia's technology sector emerges from the synergistic integration of dynamic capabilities, employee sustainability practices, and green innovation. The structural equation modeling confirms that dynamic capabilities directly enhance resilience ($\beta=0.32$, $p<0.01$) while simultaneously driving green innovation ($\beta=0.53$, $p<0.001$), with the latter mediating 43.9% of this relationship. Employee sustainability practices exert substantial direct ($\beta=0.29$, $p<0.001$) and innovation-mediated effects (VAF=40.8%) on resilience, demonstrating dual-pathway efficacy. Critically, the DC-ESP interaction term ($\beta=0.18$, $p=0.003$) reveals supra-additive innovation gains, confirming strategic interdependence where sustainability-aligned human resources amplify dynamic capability deployment. These findings reconcile Resource-Based View and Stakeholder Theory within sustainability contexts, establishing green innovation as the catalytic mechanism translating organizational adaptability and human capital investments into workforce resilience. For Indonesia's technology ecosystem, this implies that fulfilling NZE 2060 commitments requires concurrent investments in: (1) technological sensing-seizing systems to anticipate green disruptions, (2) institutionalized ESG-linked HR metrics (≥25% incentive weighting), and (3) cross-functional innovation incubators bridging R&D and sustainability teams. Future research must address longitudinal causality and incorporate unlisted startups to capture sectoral heterogeneity, but this study's robust mediation framework ($Q^2=0.61$) provides an empirically validated foundation for ASEAN's sustainable digital transformation policies.

AUTHORS' CONTRIBUTIONS

all authors involved in making substantial contributions to the conception and design, or data acquisition, or data analysis and interpretation have been involved in the preparation of the manuscript.

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This study yields critical practical implications for Indonesia's technology ecosystem: Organizations must strategically reconfigure human resource and innovation systems by (1) institutionalizing ESG-linked performance metrics (≥25% incentive weighting) to activate employee sustainability practices' dual-path efficacy, (2) allocating 30% of R&D budgets to dynamic capability development particularly emerging technology scanning to amplify green

innovation, and (3) establishing cross-functional incubators that integrate sustainability teams with R&D units to leverage the DC-ESP interaction effect (β=0.18) for supra-additive innovation gains. Policymakers should incentivize green patent portfolios through tax credits aligned with NZE 2060 targets, while investors must prioritize firms demonstrating mediated resilience pathways (VAF>40%). For academia, these findings necessitate curriculum reforms integrating sustainability transitions with digital capability modules to address sectoral skill obsolescence (32% R&D gap).

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